

Air Quality Monitoring

in the vicinity of a CNRL well blowout

February 25, 2010 to March 9, 2010

Summary report

Overview

All monitoring sites were downwind of the Canadian Natural Resources Limited (CNRL) natural gas well blowout, except Site G which was a background site.

The one-hour AAAQO for hydrogen sulphide of 0.010 ppm was not exceeded. The maximum one-hour average for hydrogen sulphide of 0.001 ppm was measured at both Site G, the background site, and Site H. These were the only two sites where hydrogen sulphide was above the detection limit. The highest one-hour total reduced sulphur concentration of 0.002 ppm was measured at Site E.

The highest median sulphur dioxide concentration was 0.004 ppm, measured at Site E. This was comparable to the maximum sulphur dioxide value recorded at Sites H and K, as well as at the background Site G. These concentrations did not exceed the one-hour AAAQO of 0.172 ppm.

Median one-hour PM_{10} concentration ranged from $0.3 \mu g/m^3$ to $52.4 \mu g/m^3$. The median one-hour $PM_{2.5}$ concentrations ranged from $0.2 \mu g/m^3$ to $37.3 \mu g/m^3$. The median one-hour PM_1 concentrations ranged from $0.2 \mu g/m^3$ to $33.2 \mu g/m^3$. All minimum values were measured at Site B, and all maximum values were measured at Site K. The measured values for $PM_{2.5}$ were all well below the AAAQG, which is a value of $80 \mu g/m^3$.



1. Introduction

Alberta Environment conducts mobile air quality surveys in emergency situations. These surveys are requested by the Alberta Environment Support and Emergency Response Team (ASERT), and in this case the department's mobile air monitoring laboratory (MAML) was deemed appropriate to analyze the air quality. The MAML is equipped to measure a number of air pollutants including ammonia, carbon monoxide, hydrocarbons, oxides of nitrogen, ozone, particulate matter, reduced sulphur compounds and sulphur dioxide.

For the current project, the emergency situation was the Canadian Natural Resources Limited (to be referred to as CNRL for the duration of the report) natural gas well blowout approximately 20 kilometers northwest of Hythe, Alberta. Monitoring was performed in the vicinity of the well blowout at twelve stationary sample sites as well as one mobile site. The surveys were conducted over a period of eight days, from February 25 to March 9, 2010, inclusive. During the sample period, over fifty hours of data were collected.

The objectives for monitoring in the Hythe area were to identify and determine the concentrations of common air pollutants near the CNRL natural gas well blowout site, and then consequently to compare them to the Alberta Ambient Air Quality Objectives. To achieve these objectives, monitoring was carried out for at least one hour at each monitoring location, and in most cases there were several hours of monitoring conducted at each site. This facilitated comparison to Alberta's Ambient Air Quality Air Quality Objectives and Guidelines (AAQOs and AAQGs). AAQOs are established to define desired environmental quality that will protect public health and ecosystems and are used by Alberta Environment to ensure good air quality through out the province.

2. Monitoring method and locations

Air quality measurements around the CNRL well blowout were performed using Alberta Environment's mobile monitoring laboratory (MAML). The MAML provides a "snapshot" in time and place of the quality of air. It's equipped to monitor ammonia, carbon monoxide, hydrocarbons, oxides of nitrogen, ozone, particulate matter, reduced sulphur compounds and sulphur dioxide simultaneously. For this incident, only sulphur dioxide (SO₂), total reduced sulphur (TRS), hydrogen sulphide (H₂S), and particulate matter with aerodynamic diameters less than 10, 2.5, and 1 micrometers (PM₁₀, PM_{2.5}, and PM₁, respectively) were measured. Descriptions of the MAML and the detection limits of its on board instruments are given in Appendix D.

The measurements were conducted for a total of eight days between February 25, 2010 and March 9, 2010. The monitoring schedule is presented in Table A3 in the appendix. In total, approximately 52 hours of data were collected at twelve stationary monitoring sites and one mobile monitoring site.

The locations of the monitoring sites are described in Table 1 and illustrated in Figure 1. Site O in Figure 1 is the location of the well blowout. Sites A-L were ambient monitoring sites. Not all sites are included in this report. Sites D and L did not have one full hour of measurement conducted, thus data collected at these sites is not discussed. Also, data from Site M was not included in the analysis, because the sample was significantly impacted by particulate matter from a gravel road. One-hour average concentrations calculated from data collected at the remainder of the sites were compared to one-hour Alberta Ambient Air Quality Objectives (AAAQO) and are discussed in the result and discussion section.

With the exception of F, G, and H, an attempt was made to monitor downwind of the blowout site. These sites are described in Table 1. Site G was upwind from the CNRL blowout site, and consequently this site is used as the background (reference) site¹. Locations F and H were located within nearby communities and chosen to ensure public safety. Also, Site J was sampled as the result of a public complaint, and factors other than the well blowout were affecting the air quality at that site, so it is not included in the report.

¹ See Wind Rose 1, 2, 3, and 4.

Table 1: Description of monitoring locations

Site	Description
A	CNRL battery, LSD = 6-22-75-11 west of 6 th
B	Incident Command Centre, on Lousy Road and Township Road 754
C	two locations along Twp Rd 750 near Security Gate #2
D ²	3 km north of Highway 59 on Range Road 115A
E	slightly further NW of incident command centre
F	Horse Lake First Nation band office parking lot
G ³	immediately east of Hythe school, on township road 733
H	Town of La Glace, east of school
I	Spring Lake campground parking lot
J ²	near Glover residence, public complaint, Range Rd 123 and Highway 43
K	Valhalla Centre
L ²	on highway 59 1 km east of range road 120
M ²	roving up and down Spring Lake road, north of township road 750
O	Origin of the plume: the well blowout site

² Data collected at these sites were not used in this report.

³ Site G is to be considered a background site.

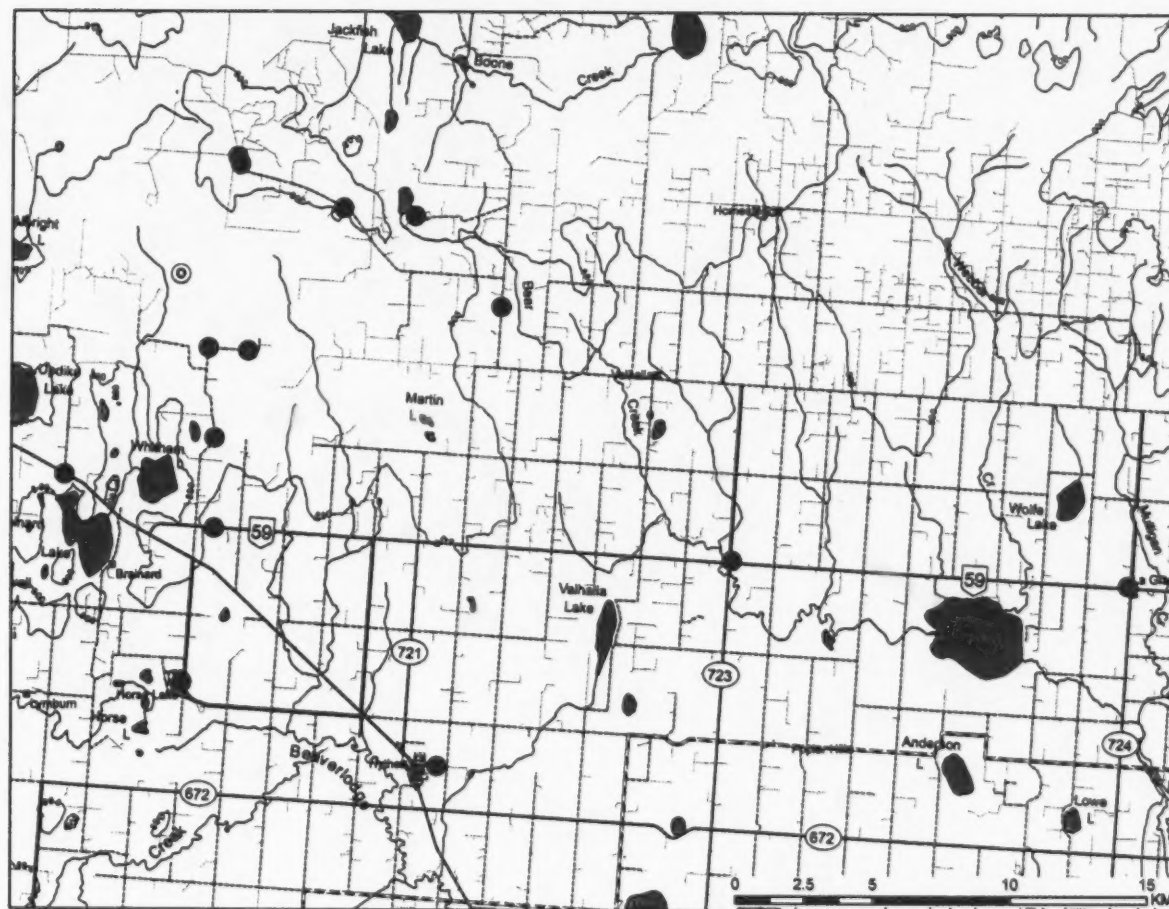


Figure 1: MAML monitoring location descriptions of the indicated sites are given in Table 1. Note that Site O is the location of the well blowout

3. Results and Discussion

At most locations, monitoring was conducted for more than one hour, and all sites included in this discussion have at least one full hour of data. In discussing the results, the median one-hour average and the maximum one-hour average concentrations are presented. The median concentration is a common way of representing the central value for environmental data. Fifty percent of the one-hour averages at a location are below the median one-hour average concentration and fifty percent are above. Further justification for using the median concentration is presented in Appendix D.

The median and maximum one-hour averages illustrate the mid as well as the highest one-hour concentrations measured at a location. These concentrations were compared to established **Alberta Ambient Air Quality Objectives and Guidelines** (AAAQO and AAAQG). The key in Figure 2 illustrates how the median and maximum one-hour average concentrations are represented in the following section.

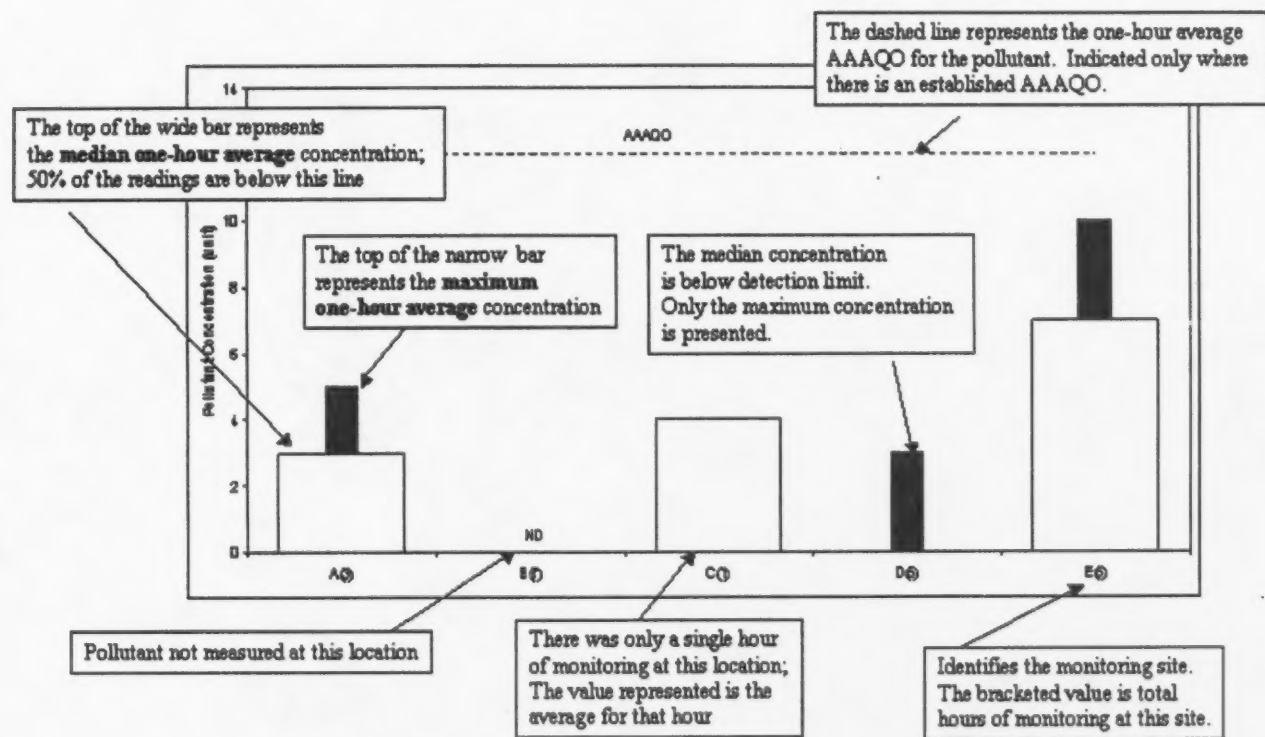


Figure 2: A key for interpreting the figures in the following section

3.1. Total Reduced Sulphur (TRS) Including Hydrogen Sulphide (H_2S)

Total reduced sulphur includes hydrogen sulphide (H_2S), mercaptans, dimethyl sulphide, and other sulphur compounds. Total reduced sulphur *does not* include sulphur dioxide, this pollutant will be discussed in a separate section. Anthropogenic sources of H_2S and TRS are fugitive emissions from "sour" natural gas wells as well as a number of industrial processes. Natural sources of H_2S include sulphur hot springs, sloughs, swamps and lakes.

The median one-hour TRS concentrations ranged from below detection limit at Site C to 0.002 ppm at Site E (Figure 3). The highest TRS concentrations were measured at Site E, located northeast of the well blowout with the median and maximum one-hour averages both 0.002 ppm. However, at the time of monitoring it was not located downwind of the well blowout.⁴

The median one-hour average H_2S concentrations at many of the monitoring locations were below detection limit (Figure 4). However, there were measurable one-hour concentrations. The maximum one-hour average concentrations ranged from below detection at most sites⁵ to 0.001 ppm. The highest one-hour average H_2S concentration of 0.001 ppm was measured at both sites where H_2S was above detection limits (Sites G and H). All measured concentrations at all sites were lower than the one-hour AAAQO for H_2S of 0.010 ppm.

At Site E, where the highest TRS concentrations occurred, the one-hour average H_2S concentration was below the detection limit. At Sites G and H, most of the detected TRS was from H_2S . The results indicate that at the other sites there were significant contributions from other reduced sulphur compounds (other than H_2S) to TRS concentrations. Measured TRS and H_2S concentrations at these sites were comparable to the maximum one-hour concentrations recorded at the background Site G.

⁴ See the Wind Rose 5 in Appendix B.

⁵ H_2S was only detected at Sites G and H.

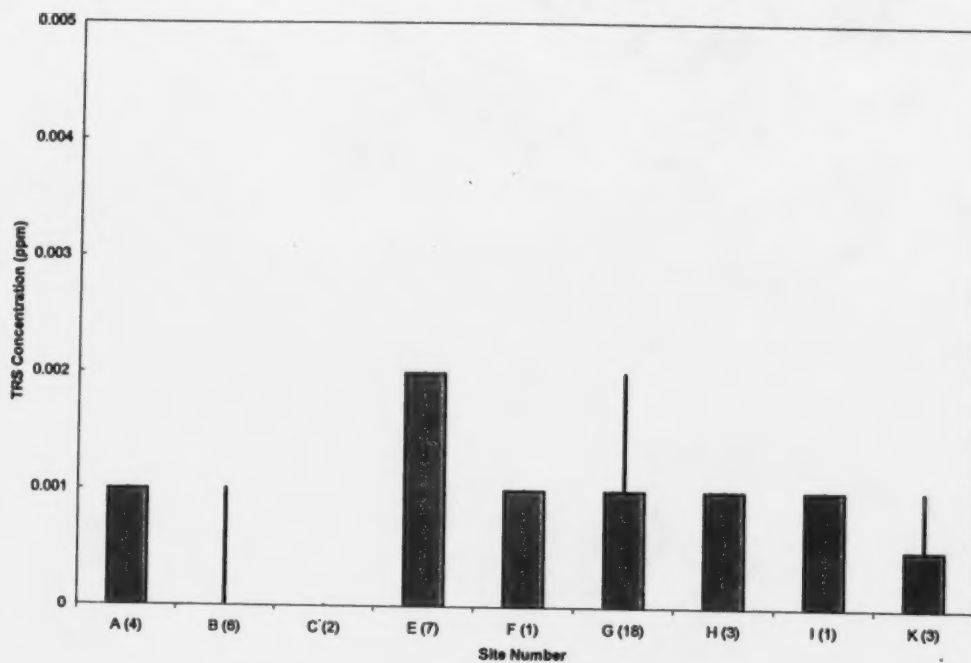


Figure 3: Median and maximum one-hour average concentrations for TRS.

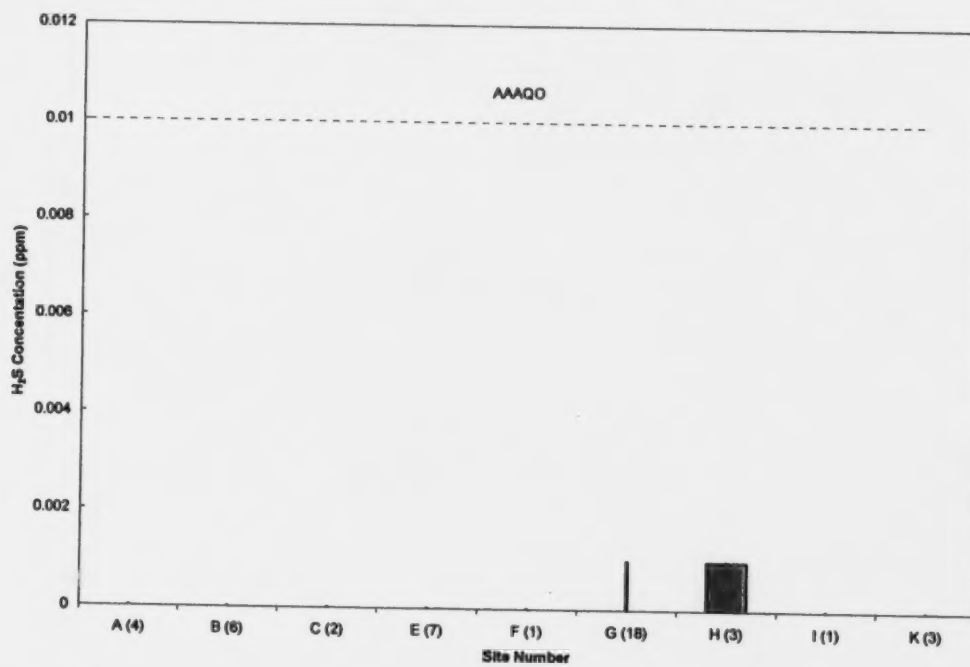


Figure 4: Median and maximum one-hour average concentrations for H₂S.

Sulphur Dioxide (SO₂)

In Alberta, upstream oil and gas processes are responsible for close to half of the sulphur dioxide (SO₂) emissions in the province. Oil sands facilities and power plants are also major sources of SO₂. Other sources include gas plants, flares, oil refineries, pulp and paper mills and fertilizer plants.

One hour average median SO₂ concentrations ranged from below detection to 0.004 ppm. The highest median SO₂ concentration was measured at Site E. This was comparable to the maximum SO₂ value recorded at Sites H and K, as well as at the background Site G (Figure 5). These concentrations did not exceed the one-hour AAAQO of 0.172 ppm (Figure 6).

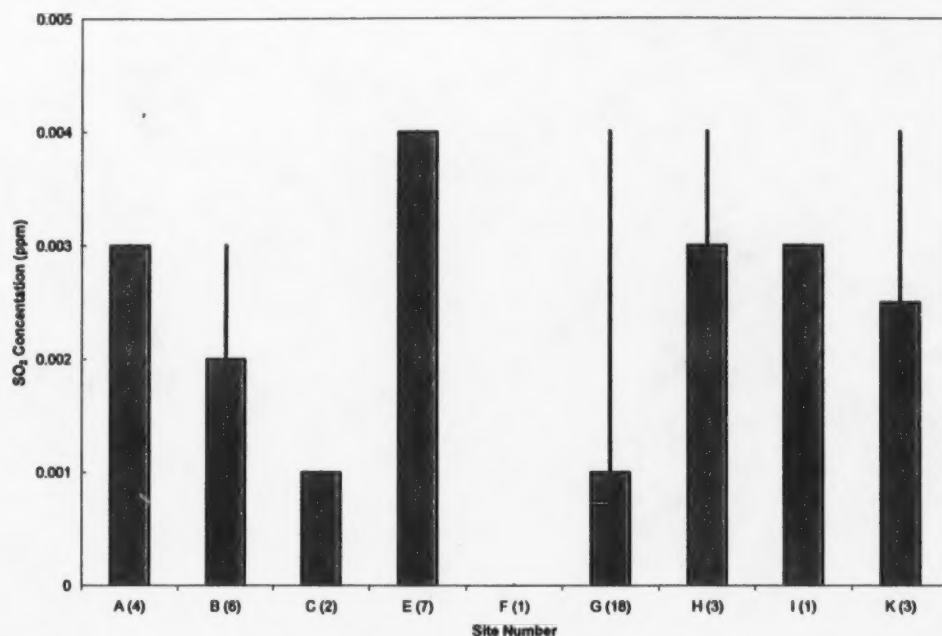


Figure 5: Median and maximum one-hour average SO₂ concentrations.

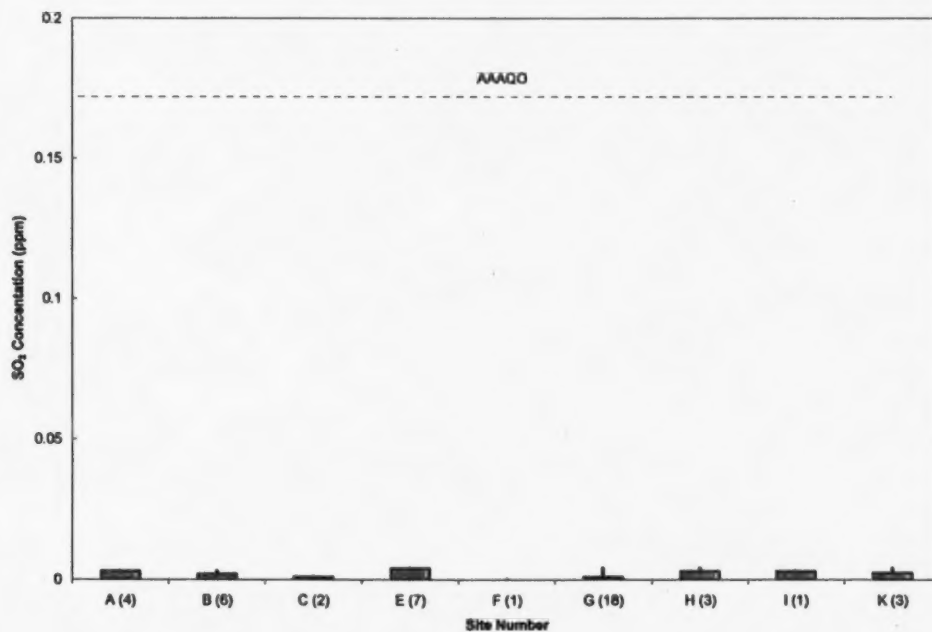


Figure 6: Median and maximum one-hour average SO₂ concentrations in comparison to the AAAQO.

Particulate Matter (PM_{10} , $PM_{2.5}$, and PM_1)

Inhalable particulates are particulate matter less than 10 micrometers in aerodynamic diameter (PM_{10}) that can be inhaled into the nose and throat. Sources of PM_{10} include soil dust, road dust, agricultural dust (e.g., harvest), smoke from forest fires and wood burning, vehicle exhaust and industrial emissions. Respirable particulates are particulate matter less than 2.5 micrometers ($PM_{2.5}$ and PM_1) in aerodynamic diameter. $PM_{2.5}$ and PM_1 are small enough to penetrate into the lungs. Respirable particulates may form in the atmosphere and/or arise from combustion sources such as vehicle exhaust emissions, industrial emissions and wood burning.

Median one-hour PM_{10} concentration ranged from $0.3 \mu\text{g}/\text{m}^3$ to $52.4 \mu\text{g}/\text{m}^3$. The median one-hour $PM_{2.5}$ concentrations ranged from $0.2 \mu\text{g}/\text{m}^3$ to $37.3 \mu\text{g}/\text{m}^3$. The median one-hour PM_1 concentrations ranged from $0.2 \mu\text{g}/\text{m}^3$ to $33.2 \mu\text{g}/\text{m}^3$. All minimum values were measured at Site B, and all maximum values were measured at Site K. All measured values of PM_{10} , $PM_{2.5}$, and PM_1 are comparable to the background values measured at Site G or lower.

It is significant to note that higher values for PM_{10} , $PM_{2.5}$, and PM_1 were recorded at Site J. Site J was monitored as a result of a public complaint, relating to smoke in the area as a result of waste being burned on a neighboring property. The measured values for $PM_{2.5}$ were all well below the AAAQG, which is a value of $80 \mu\text{g}/\text{m}^3$, even at Site J. Although the data for Site J is not included in Figures 7, 8, or 9, it is included in the raw data located in Appendix C.

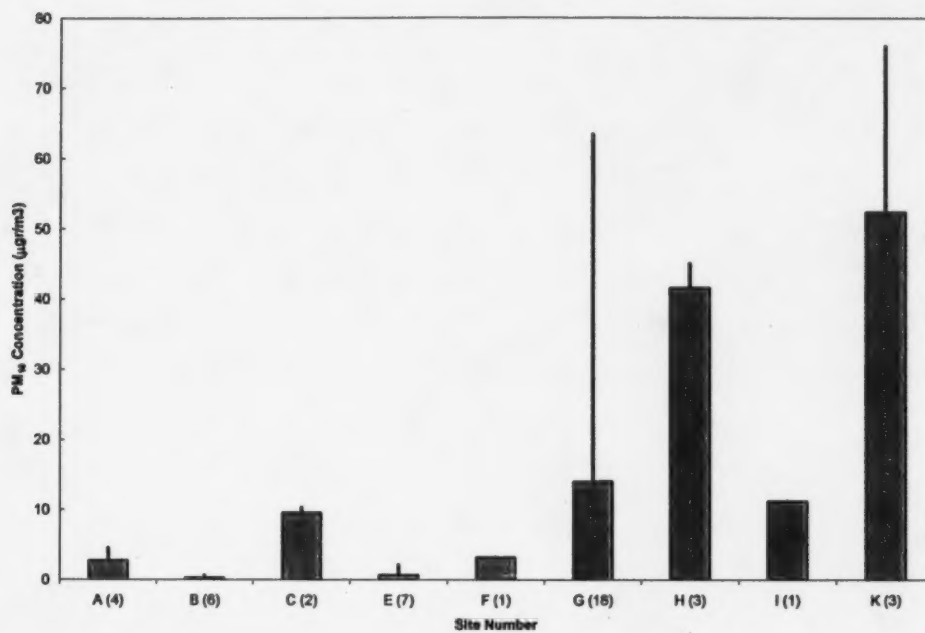


Figure 7: Median and maximum one-hour average PM₁₀ concentrations

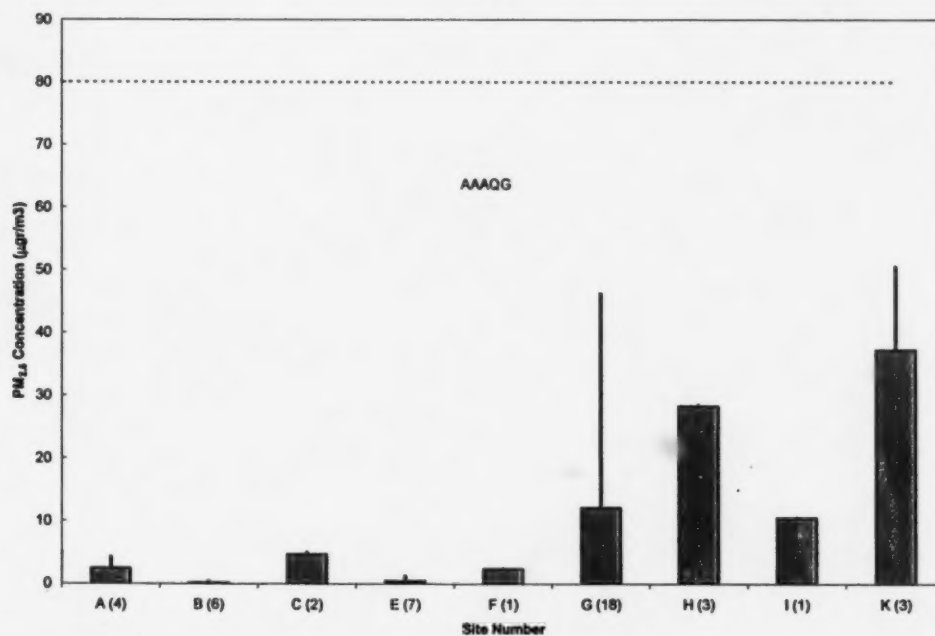


Figure 8: Median and maximum one-hour average PM_{2.5} concentrations

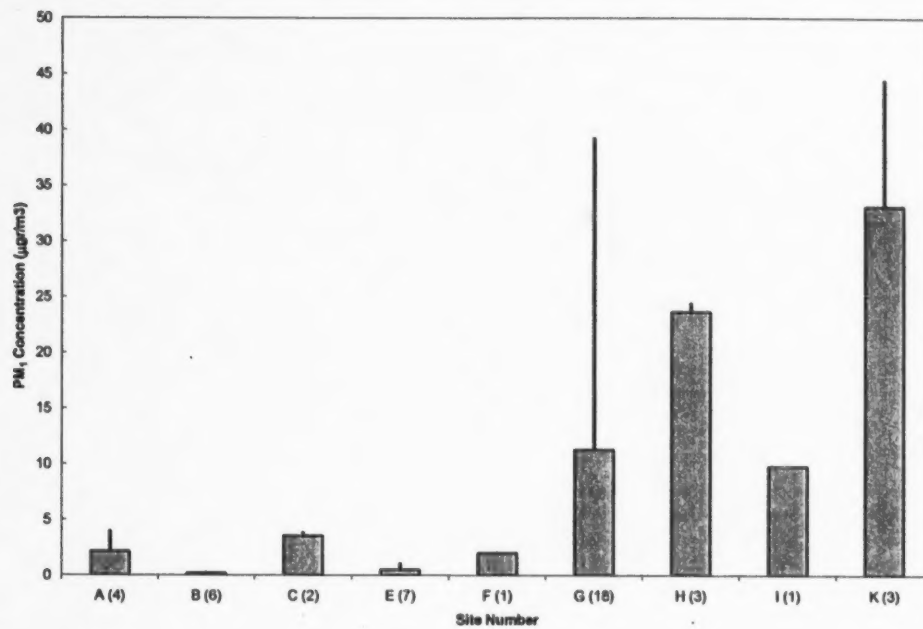


Figure 9: Median and maximum one-hour average PM₁ concentrations

Appendix A

Table A1: February: Operator's comment and meteorological conditions measured at monitoring locations

Date	Start/End Times	Site	Location	Comments	Temp	RH	WSP	WDR
25-Feb-10	07:55 to 08:55	A	CNRL battery		2.9	97.5	2.7	186
25-Feb-10	08:55 to 09:55	A	CNRL battery		0.1	82.0	3.4	210
25-Feb-10	09:55 to 10:55	A	CNRL battery		2.6	63.7	7.9	107
25-Feb-10	10:55 to 11:55	A	CNRL battery		4.7	60.8	11.1	195
25-Feb-10	12:33 to 13:33	B	command centre		8.9	48.6	10.5	240
25-Feb-10	13:33 to 14:33	B	command centre		7.3	41.1	9.2	235
25-Feb-10	14:33 to 15:33	B	command centre		7.3	40.3	9.5	232
25-Feb-10	15:33 to 16:33	B	command centre		6.5	40.7	9.0	218
25-Feb-10	16:33 to 17:33	B	command centre		5.4	50.0	7.9	212
25-Feb-10	17:33 to 18:26	B	command centre		3.9	57.7	8.5	204
26-Feb-10	08:27 to 09:27	E	NW of command centre		0.3	85.9	7.0	137
26-Feb-10	09:27 to 10:27	E	NW of command centre		2.4	74.1	5.8	138
26-Feb-10	10:27 to 11:27	E	NW of command centre		3.9	68.4	11.2	140
26-Feb-10	11:27 to 12:27	E	NW of command centre		5.5	57.3	9.7	179
26-Feb-10	12:27 to 13:27	E	NW of command centre		7.6	46.1	5.7	140
26-Feb-10	13:27 to 14:27	E	NW of command centre		6.1	49.9	7.1	121
26-Feb-10	14:27 to 15:27	E	NW of command centre		5.4	49.9	6.4	125
26-Feb-10	17:14 to 18:21	F	Horse Lake band office		2.8	71.5	9.2	55
26-Feb-10	18:44 to 19:45	G	east of Hythe school		0.6	81.5	13.1	56
27-Feb-10	07:29 to 08:29	G	east of Hythe school		-2.0	83.3	3.5	205
27-Feb-10	08:29 to 09:29	G	east of Hythe school		-1.5	81.9	3.0	160
27-Feb-10	09:29 to 10:29	G	east of Hythe school		-0.9	80.9	3.4	192
27-Feb-10	10:29 to 11:29	G	east of Hythe school		0.3	79.1	3.8	276
27-Feb-10	12:23 to 13:23	G	east of Hythe school	Passing traffic	0.5	85.3	6.4	254
27-Feb-10	13:23 to 14:23	G	east of Hythe school		2.6	76.1	1.9	154
27-Feb-10	14:23 to 15:23	G	east of Hythe school		1.5	82.0	4.9	82
27-Feb-10	15:23 to 16:23	G	east of Hythe school		1.5	83.1	4.2	271
28-Feb-10	07:50 to 08:50	G	east of Hythe school		-8.1	102.1	3.3	270
28-Feb-10	08:50 to 09:50	G	east of Hythe school		-7.6	102.1	2.7	194
28-Feb-10	09:50 to 10:50	G	east of Hythe school		-7.1	102.2	3.1	63
28-Feb-10	12:50 to 13:50	G	east of Hythe school		-1.2	90.5	8.3	71
28-Feb-10	13:50 to 14:50	G	east of Hythe school		0.4	89.1	8.1	56

Table A1: February: Operator's comment and meteorological conditions measured at monitoring locations

Date	Start/End Times	Site	Location	Comments	Temp	RH	WSP	WDR
1-Mar-10	07:20 to 08:20	G	east of Hythe school		-8.2	98.7	3.5	188
1-Mar-10	08:20 to 09:20	G	east of Hythe school		-8.2	96.9	3.6	170
1-Mar-10	10:20 to 11:24	H	La Glace, east of school		0.0	74.5	3.3	150
1-Mar-10	11:34 to 12:34	H	La Glace, east of school		0.6	67.6	3.3	86
1-Mar-10	12:34 to 13:34	H	La Glace, east of school		3.6	62.4	2.5	132
1-Mar-10	15:14 to 16:14	K	Valhalla Centre		2.7	75.5	4.9	113
1-Mar-10	17:31 to 18:31	J	Spring Lake campground parking lot		4.4	63.8	2.6	168
2-Mar-10	13:37 to 14:37	J	Glover residence public complaint	extremely smoky, burning waste wood in nearby field	9.8	46.8	2.9	182
2-Mar-10	15:55 to 16:55	K	valhalla Centre		7.7	61.7	3.7	179
9-Mar-10	14:19 to 15:19	C	Twp Rd 750 near Security Gate #2		0.001	ND	0.000	1.1
9-Mar-10	15:19 to 16:19	C	Twp Rd 750 near Security Gate #2		0.001	ND	0.000	0.4

Notes:

Temp - Temperature in degrees centigrade

RH - Relative humidity in percentage

WSP - Wind speed in Km/hr

WDR - Wind direction in degrees

Table A2: Median one-hour average concentrations at monitoring locations.

Site (# of Samples)	SO ₂ (ppm)	TRS (ppm)	H ₂ S (ppm)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM ₁ (µg/m ³)
A (4)	0.003	0.001	bdl	2.75	2.45	2.15
B (6)	0.002	bdl	bdl	0.3	0.2	0.2
C (2)	0.001	bdl	bdl	9.55	4.7	3.55
D (0)	n/a	n/a	n/a	n/a	n/a	n/a
E (7)	0.004	0.002	bdl	0.7	0.5	0.5
F (1)	bdl	0.001	bdl	3.2	2.4	2
G (18)	0.001	0.001	bdl	14.1	12.2	11.3
H (3)	0.003	0.001	0.001	41.6	28.3	23.7
I (1)	0.003	0.001	bdl	11.2	10.5	9.8
J (1)	0.001	0.001	bdl	89	51.6	41.9
K (3)	0.003	0.0005	bdl	52.4	37.3	33.2
L (0)	n/a	n/a	n/a	n/a	n/a	n/a

Table A3: Maximum one-hour average concentrations at monitoring locations.

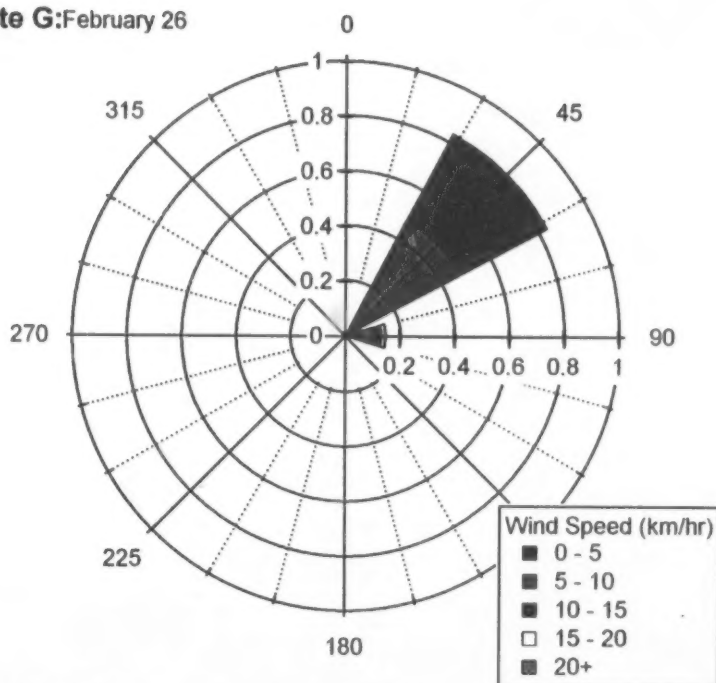
Site (# of Samples)	SO ₂ (ppm)	TRS (ppm)	H ₂ S (ppm)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM ₁ (µg/m ³)
A (4)	bdl	0.001	bdl	4.5	4.2	3.9
B (6)	bdl	0.001	bdl	0.6	0.4	0.2
C (2)	bdl	bdl	bdl	10.3	5	3.8
D (0)	n/a	n/a	n/a	n/a	n/a	n/a
E (7)	bdl	0.002	bdl	2.1	1.2	1
F (1)	bdl	0.001	bdl	3.2	2.4	2
G (18)	0.004	0.002	0.001	63.4	46.2	39.2
H (3)	0.004	0.001	0.001	45	28.5	24.4
I (1)	bdl	bdl	bdl	11.2	10.5	9.8
J (1)	bdl	bdl	bdl	89	51.6	41.9
K (3)	bdl	bdl	bdl	76	50.5	44.4
L (0)	n/a	n/a	n/a	n/a	n/a	n/a

Notes: bdl – below detection limit
µg/m³ = micrograms per cubic meter

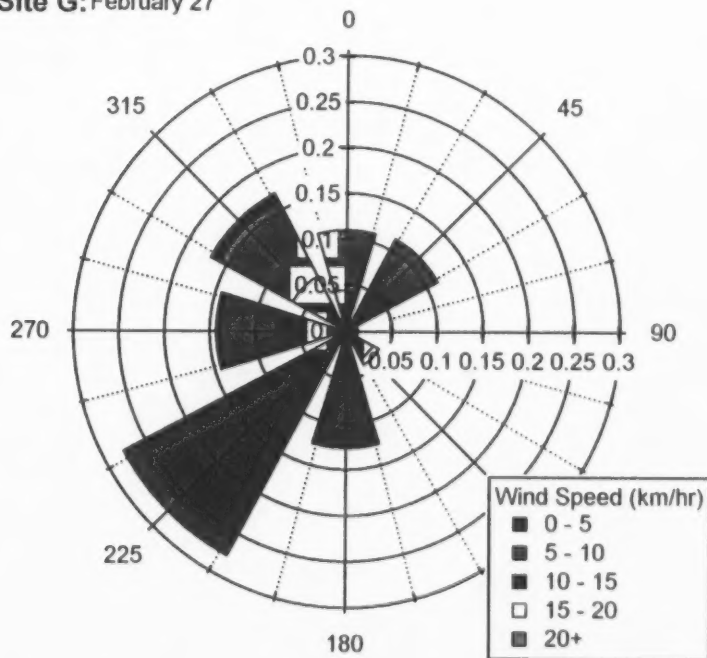
ppm - parts per million
n/a – Parameter not monitored or data not available.

Appendix B

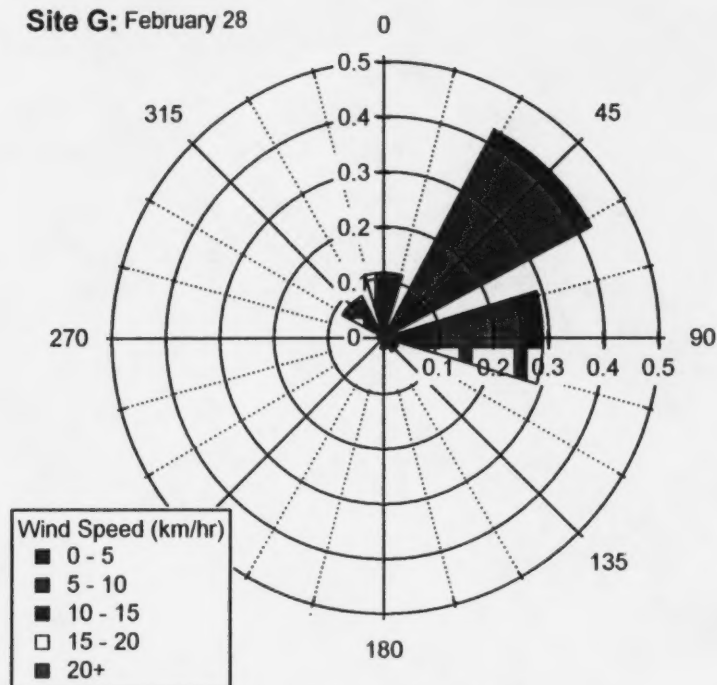
Site G: February 26



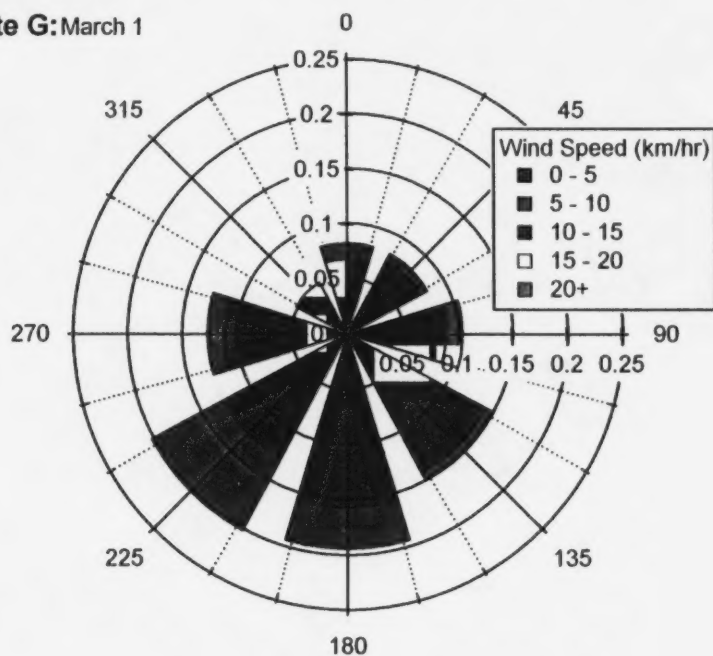
Site G: February 27



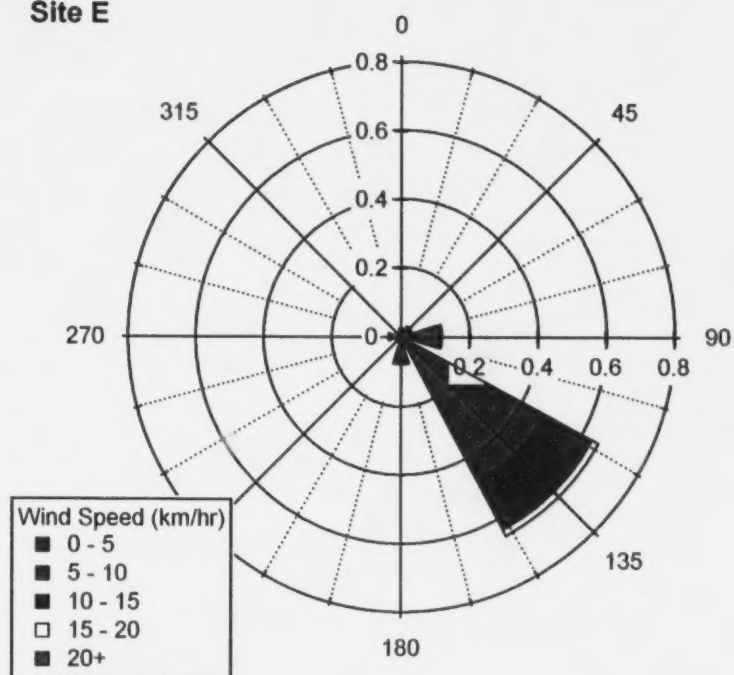
Site G: February 28



Site G: March 1



Site E



Wind Rose 5: 0 indicates north, 90 east, 180 south and 270 west.

Appendix C

All One-hour Averaged Data

Date	Site	Start/End Times	SO2 (PPM)	TRS (PPM)	H2S (PPM)	Temp (DEG C)	RH (%)	WSP (KPH)	WDR (DEG)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM ₁ (µg/m ³)	THC (PPM)	CH4 (PPM)	RHC (PPM)
25-Feb-10	A	07:55 to 08:55	0.003	0.001	0.000	-2.9	97.5	2.7	188	3.6	3.1	2.7	ND	ND	ND
25-Feb-10	A	08:55 to 09:55	0.003	0.001	0.000	0.1	82.0	3.4	210	4.5	4.2	3.9	ND	ND	ND
25-Feb-10	A	09:55 to 10:55	0.003	0.001	0.000	2.6	69.7	7.9	195	1.9	1.8	1.6	ND	ND	ND
25-Feb-10	A	10:55 to 11:55	0.003	0.001	0.000	4.7	60.8	11.1	195	1.2	1.1	1.0	ND	ND	ND
25-Feb-10	A	11:55 to 12:00	<0.002	<0.001	<0.000	<5.2	<59.5	<12.6	<212	<1.1	<1.1	<1.1	ND	ND	ND
25-Feb-10	B	12:33 to 13:33	0.003	0.000	0.000	6.9	48.6	10.5	214	0.3	0.2	0.2	ND	ND	ND
25-Feb-10	B	13:33 to 14:33	0.002	0.001	0.000	7.3	41.1	9.2	235	0.4	0.3	0.2	ND	ND	ND
25-Feb-10	B	14:33 to 15:33	0.002	0.001	0.000	7.3	40.3	9.6	232	0.6	0.4	0.2	ND	ND	ND
25-Feb-10	B	15:33 to 16:33	0.002	0.000	0.000	6.5	40.7	9.0	218	0.3	0.2	0.1	ND	ND	ND
25-Feb-10	B	16:33 to 17:33	0.001	0.000	0.000	5.4	50.0	7.9	212	0.3	0.2	0.2	ND	ND	ND
25-Feb-10	B	17:33 to 18:26	0.000	0.000	0.000	3.9	57.7	8.5	204	0.3	0.2	0.2	ND	ND	ND
9-Mar-10	C	14:19 to 15:19	0.001	ND	0.000	1.1	30.2	6.4	196	10.3	4.4	3.3	1.8	1.4	0.4
9-Mar-10	C	15:19 to 16:19	0.001	ND	0.000	0.4	30.9	8.2	182	8.8	5.0	3.8	1.8	1.7	0.1
9-Mar-10	D	16:26 to 16:49	<0.001	ND	<0.000	<0.2	<31.7	<5.0	<194	<12.6	<6.7	<5.3	<1.7	<1.7	<0.0
26-Feb-10	E	08:27 to 09:27	0.004	0.001	0.000	-0.3	85.9	7.8	137	1.4	1.2	1.0	ND	ND	ND
26-Feb-10	E	09:27 to 10:27	0.004	0.001	0.000	2.4	74.1	5.8	138	0.7	0.5	0.5	ND	ND	ND
26-Feb-10	E	10:27 to 11:27	0.004	0.001	0.000	3.9	66.4	11.2	140	0.7	0.5	0.5	ND	ND	ND
26-Feb-10	E	11:27 to 12:27	0.003	0.002	0.000	5.5	57.3	9.7	179	0.6	0.6	0.6	ND	ND	ND

Date	Site	Start/End Times	SO2 (PPM)	TRS (PPM)	H2S (PPM)	Temp (DEG C)	RH (%)	WSP (KPH)	WDR (DEG)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM ₁ (µg/m ³)	THC (PPM)	CH4 (PPM)	RHC (PPM)
26-Feb-10	E	12:27 to 13:27	0.004	0.002	0.000	7.8	48.1	5.7	140	0.6	0.4	0.4	ND	ND	ND
26-Feb-10	E	13:27 to 14:27	0.004	0.002	0.000	6.1	49.9	7.1	121	0.6	0.5	0.4	ND	ND	ND
26-Feb-10	E	14:27 to 15:27	0.003	0.002	0.000	5.4	49.9	6.4	125	2.1	0.9	0.6	ND	ND	ND
26-Feb-10	E	15:27 to 16:03	0.002	0.002	0.000	5.4	48.0	5.1	135	2.1	0.9	0.6	ND	ND	ND
26-Feb-10	F	17:14 to 18:21	0.000	0.001	0.000	2.8	71.5	9.2	55	3.2	2.4	2.0	ND	ND	ND
26-Feb-10	G	18:44 to 19:45	0.000	0.001	0.000	0.6	81.5	13.1	56	2.9	2.6	2.3	ND	ND	ND
27-Feb-10	G	07:29 to 08:29	0.003	0.002	0.000	-2.0	83.3	3.5	205	12.0	9.1	8.1	ND	ND	ND
27-Feb-10	G	08:29 to 09:29	0.001	0.001	0.000	-1.5	81.9	3.0	160	11.9	8.8	7.8	ND	ND	ND
27-Feb-10	G	09:29 to 10:29	0.001	0.001	0.000	-0.9	80.9	3.4	192	15.6	13.0	11.7	ND	ND	ND
27-Feb-10	G	10:29 to 11:29	0.001	0.001	0.000	0.3	78.1	3.8	276	13.6	9.5	8.4	ND	ND	ND
27-Feb-10	G	11:29 to 11:50	<0.000	<0.001	<0.000	<0.0	<81.3	<6.7	<327	<12.1	<9.9	<9.0	ND	ND	ND
27-Feb-10	G	12:23 to 13:23	0.000	0.000	0.000	0.5	85.3	6.4	254	12.8	11.2	10.2	ND	ND	ND
27-Feb-10	G	13:23 to 14:23	0.001	0.001	0.000	2.6	76.1	1.9	154	14.5	11.9	10.9	ND	ND	ND
27-Feb-10	G	14:23 to 15:23	0.001	0.000	0.000	1.5	82.0	4.9	82	15.8	14.0	13.0	ND	ND	ND
27-Feb-10	G	15:23 to 16:23	0.002	0.000	0.000	1.5	83.1	4.2	271	22.1	15.1	13.5	ND	ND	ND
27-Feb-10	G	16:23 to 17:00	0.001	0.000	0.000	0.7	88.0	8.2	334	19.9	17.3	15.8	ND	ND	ND
28-Feb-10	G	07:50 to 08:50	0.002	0.001	0.000	-8.1	102.1	3.3	270	ND	ND	ND	ND	ND	ND
28-Feb-10	G	08:50 to 09:50	0.002	0.001	0.000	-7.6	102.1	2.7	194	5.5	3.6	3.4	ND	ND	ND

Date	Site	Start/End Times	SO2 (PPM)	TRS (PPM)	H2S (PPM)	Temp (DEG C)	RH (%)	WSP (KPH)	WDR (DEG)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM ₁ (µg/m ³)	THC (PPM)	CH4 (PPM)	RHC (PPM)
28-Feb-10	G	09:50 to 10:50	0.004	0.001	0.000	-7.1	102.2	3.1	63	30.1	20.1	16.7	ND	ND	ND
28-Feb-10	G	12:50 to 13:50	0.002	0.001	0.000	-1.2	90.5	8.3	71	12.6	12.4	12.2	ND	ND	ND
28-Feb-10	G	13:50 to 14:50	0.001	0.001	0.000	0.4	89.1	8.1	56	16.0	14.9	14.2	ND	ND	ND
28-Feb-10	G	14:50 to 15:00	<0.001	<0.001	<0.000	<0.1	<91.4	<8.6	<59	<17.4	<16.9	<16.2	ND	ND	ND
1-Mar-10	G	07:20 to 08:20	0.015	0.001	0.004	-8.8	98.5	3.5	186	58.0	47.3	43.4	ND	ND	ND
1-Mar-10	G	08:20 to 09:20	0.002	0.001	0.001	-8.2	96.9	3.6	170	63.4	46.2	39.2	ND	ND	ND
1-Mar-10	G	09:20 to 09:33	<0.002	<0.002	<0.002	<-6.4	<92.2	<3.3	<125	<63.1	<48.1	<42.6	ND	ND	ND
1-Mar-10	H	10:34 to 11:34	0.003	0.001	0.001	0.0	74.6	3.2	120	34.4	21.0	16.9	ND	ND	ND
1-Mar-10	H	11:34 to 12:34	0.003	0.001	0.001	0.6	67.6	3.3	86	41.6	28.3	24.4	ND	ND	ND
1-Mar-10	H	12:34 to 13:34	0.004	0.001	0.000	3.8	62.4	2.5	132	45.0	28.5	23.7	ND	ND	ND
1-Mar-10	I	17:31 to 18:31	0.003	0.001	0.000	4.4	63.8	2.6	168	11.2	10.5	9.8	ND	ND	ND
2-Mar-10	J	13:37 to 14:37	0.001	0.001	0.000	9.8	46.8	2.9	182	89.0	51.6	41.9	ND	ND	ND
2-Mar-10	J	14:37 to 14:54	<0.001	<0.000	<0.000	<10.1	<45.1	<3.2	<280	<67.7	<32.0	<24.4	ND	ND	ND
1-Mar-10	K	15:14 to 16:14	0.004	0.001	0.000	2.7	75.5	4.9	113	28.8	24.0	21.9	ND	ND	ND
2-Mar-10	K	16:55 to 16:55	0.001	0.000	0.000	7.7	61.7	3.7	179	76.0	50.5	44.4	ND	ND	ND
2-Mar-10	K	16:55 to 17:26	0.001	0.000	0.000	6.6	66.3	4.0	251	69.7	46.5	41.2	ND	ND	ND
9-Mar-10	L	16:55 to 17:35	0.001	ND	0.000	-0.7	47.5	6.3	50	25.3	10.2	7.7	1.8	1.8	0.0
8-Mar-10	M	11:29 to 12:28	0.000	ND	0.000	-1.5	32.8	25.5	285	109.5	10.9	1.8	1.7	1.7	0.0

Date	Site	Start/End Times	SO2 (PPM)	TRS (PPM)	H2S (PPM)	Temp (DEG C)	RH (%)	WSP (KPH)	WDR (DEG)	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	PM ₁ (µg/m ³)	THC (PPM)	CH4 (PPM)	RHC (PPM)
8-Mar-10	M	12:28 to 13:28	0.000	ND	0.000	0.5	26.3	21.0	107	46.3	7.1	1.2	1.7	1.7	0.0
8-Mar-10	M	13:28 to 14:28	0.000	ND	0.000	0.9	21.9	24.7	102	22.7	3.0	0.8	1.7	1.7	0.0
8-Mar-10	M	14:28 to 15:28	0.000	ND	0.000	2.5	23.5	ND	ND	89.4	27.4	3.1	1.7	1.7	0.0
8-Mar-10	M	15:28 to 16:28	0.000	ND	0.000	2.7	27.4	10.6	97	45.0	6.7	1.1	1.7	1.7	0.0
8-Mar-10	M	16:28 to 16:49	<0.000	ND	<0.000	<1.4	<29.5	<12.6	<178	<57.2	<11.9	<1.6	<1.7	<1.7	<0.0
8-Mar-10	M	16:49 to 17:55	0.000	ND	0.000	0.6	33.4	19.8	278	55.2	9.1	1.4	1.7	1.7	0.0

Notes:

Temp (DEG C) - Temperature in degrees centigrade

WSP (KPH) – Wind speed in kilometers per hour

ND – no data

PPM – parts per million

RH (%) – Relative humidity in percentage

WDR (DEG) – Wind direction in degrees

< - Less than 30 minutes of data is use to calculate an average

µg/m³ – micro grams per cubic meter

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Appendix D

The median concentration

The median concentration is a common way of representing the central value for environmental data. Most environmental data usually consist of a distribution that is skewed to the right; that is most data values are low and only a few are high. For such data sets, the arithmetic mean will be biased by the high concentrations; the resulting value may not be representative of the central value for the data set. For example, a data distribution consisting of five numbers: 1, 2, 2, 3 and 10. The arithmetic mean of these data is 3.6 and the median is 2. In this case, the arithmetic mean is biased high by the extreme value of 10. The median is the middlemost value in the data set; thus more representative of the central value of the data distribution. Fifty percent of the values in the dataset are below the median and fifty percent are above.

Alberta's Ambient Air Quality Objectives

Alberta's Ambient Air Quality Objectives¹ are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta.

The Ambient Air Quality Objectives are used for:

- Reporting on the state of the atmospheric environment in Alberta.
- Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).
- Establishing approval conditions for regulated industrial facilities.
- Evaluating proposals to construct facilities that will have air emissions.
- Guiding special ambient air quality surveys.
- Assessing compliance near major industrial air emission sources.

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health.

Alberta's Ambient Air Quality Objectives for one-hour average concentration of pollutants monitored by the MAML are listed in Table A5.

Table A5: Alberta's Ambient Air Quality Objective measured by the MAML

Pollutant	One-hour AAAQO (ppm*)	Basis for Objective
Ammonia	2	odour perception
Carbon monoxide	13	oxygen carrying capacity of blood
Nitrogen dioxide	0.212	odour perception
Ozone	0.082	reduction of lung function and effects on vegetation
Hydrogen sulphide	0.01	odour perception
Sulphur dioxide	0.172	pulmonary function

ppm= parts per billion

¹ Alberta Ambient Air Quality Objectives. Alberta Environment. April 2005.

The Mobile Air Monitoring Laboratory (MAML)

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- a dual computer system custom-programmed to accept and record the measurement of air samples from each analyser,
- a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta,
- an exhaust purifying system that minimizes emissions from the vehicle and
- two on-board generators that are also equipped with exhaust scrubbers

Table A6 lists the pollutants and meteorological data monitored by the MAML. Also indicated are the lower and upper detection limits for each monitored species.



Figure A1: Alberta Environment's Mobile Air Monitoring Laboratory

Table A6: Pollutants and meteorological data monitoring by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	Upper Detection Limit**
Ammonia (NH ₃)	0.001 ppm	5 ppm
Ozone (O ₃)	0.001 ppm	0.5 ppm
Carbon Monoxide (CO)	0.1 ppm	50 ppm
Hydrocarbons		
Methane (CH ₄)	0.1 ppm	20 ppm
Reactive Hydrocarbons (RHC)	0.1 ppm	20 ppm
Total Hydrocarbons (THC)	0.1 ppm	20 ppm
Polycyclic Aromatic Hydrocarbons (PAH)	3 ng/m ³	1000 ng/m ³
Oxides of nitrogen		
Nitrogen dioxide (NO ₂)	0.0006 ppm	1 ppm
Nitric Oxide (NO)	0.0006 ppm	1 ppm
Oxides of nitrogen (NO _x)	0.0006 ppm	1 ppm
Particulate Matter		
Particulate Matter <1µm (PM ₁)	1 µg/m ³	1.0 g/m ³
Particulate Matter <2.5µm (PM _{2.5})	1 µg/m ³	1.0 g/m ³
Particulate Matter <10µm (PM ₁₀)	1 µg/m ³	1.0 g/m ³
Sulphur Compounds		
Hydrogen Sulphide (H ₂ S)	0.001 ppm	1 ppm
Total Reduced Sulphur (TRS)	0.001 ppm	1 ppm
Sulphur Dioxide (SO ₂)	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
Relative humidity	0%	100%

ppm - parts per million

ng/m³ = nanograms per cubic meter

µg/m³ = micrograms per cubic meter

g/m³ = grams per cubic meter

* The **lower detection limit** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The **upper detection limit** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.

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